Agricultural Research Institute, Pusa

Directions for the Cultivation of Eri Silk

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1912

PREFACE.

THIS Bulletin is written to provide rearers and intending rearers of Eri-worms with a brief practical manual on the subject. It is substantially a revision of the pamphlet entitled "Eri Silk as a Cottage Industry in the United Provinces" which was prepared by this Department and issued at the Allahabad Exhibition in 1909-1910, and which is now out of print.

A more detailed account will be found in the Memoir on "Eri Silk," by H. Maxwell Lefroy and C. C. Ghosh, published as Part I of Volume IV of the series of Entomological Memoirs issued by the Department of Agriculture, and this work should be referred to by those who desire fuller details. The information given in this present Bulletin is, however, believed to be sufficient to meet the needs of practical rearers on a small scale.

T. BAINBRIGGE FLETCHER,
Officiating Imperial Entomologist.

PUSA;
The 22nd March 1912.

Directions for the Cultivation of Eri Silk

INTRODUCTORY.

ERI-WORMS are silk-worms which feed on the leaves of the ordinary castor-oil plant. They can be reared in any part of India where castor-leaves are obtainable, but they will not thrive in the *dry* hot weather which occurs in the plains between March and the break of the monsoon. It is very difficult to rear them then, and it can only be done by sprinkling water over the walls and floor of the rearing-house to create a moist atmosphere. We recommend would-be rearers to commence during the rains and to keep on rearing continuous broods until the end of the cold weather (in localities where frost is prevalent it will be better to rear up to the beginning of the cold weather only), when the broods should be reduced and only enough worms kept to continue the race until the rains set in.

What we recommend.

In any case, we do not recommend the rearing of Eri-worms on a large scale, except under very exceptional conditions and after considerable experience on the part of the rearer. What we recommend is that Eri-worms should be reared as a cottage industry, that is to say, that they should be reared by cultivators as a subsidiary source of income. The rearing can be done and the silk spun into thread in any cultivator's own house, whilst he is working in his fields, thus providing ample light remunerative work for his female relatives and children.

Eri silk as a cottage industry.

The silk is far stronger and more lasting than cotton, but is spun and woven in the same way, and the thread can easily be woven in any ordinary village loom to make an excellent cloth which it is almost impossible to wear out.

One great advantage of the cultivation of Eri silk is that no life is taken during any process. In the case of mulberry silk-worms the silk of the

No life is taken.

cocoon is in one long continuous thread, and the cocoon must be killed or the emergence of the moth would break the thread and prevent it from being reeled. Eri cocoons cannot be reeled, as the silk is not in one thread; they must be spun and therefore there is no reason to kill the cocoon. A further advantage is this, that all the cocoons reared can be converted into thread and all the moths which emerge can be used for breeding, so that large broods can be built up rapidly without wasting cocoons for seed.

THE SILK-WORM HOUSE.

Eri-worms can be reared in any house, provided that it is ventilated. A special house is not required for rearing on a small scale, such as we recommend here. The ordinary mud-walled house with a thatched roof is quite suitable. The floor must be kept clean and free from dust; with an earthen floor, this can be done by sprinkling water over it in the hot weather. It is most important to keep the worms free from dust and in an airy place.

THINGS TO BE GOT READY BEFORE STARTING TO REAR.

Supposing that plenty of castor-leaves are available, the following things are to be got ready before starting to rear:—

(*a*) Trays for feeding the worms (Fig. 1). These are made

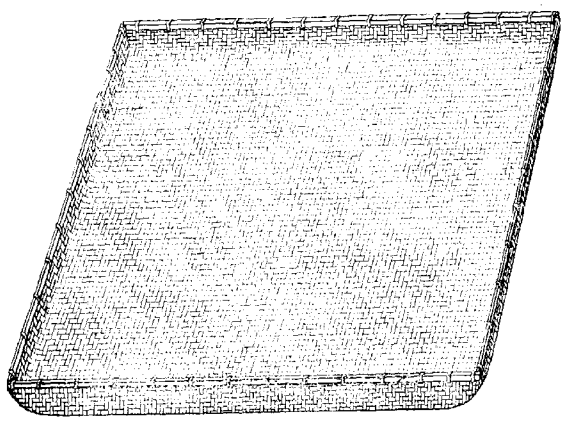

Fig. 1.—Feeding-tray.

of any convenient material, such as split-bamboo matting, the edges being turned up slightly on all four sides. The most convenient size is about 3 feet long

by 2 feet wide, and three such trays will be required for every thousand worms which it is intended to rear. If trays cannot be made of matting locally, wooden frames with thin cloth attached to them may be used.

(*b*) Small round baskets or trays (Fig. 2), in which to keep

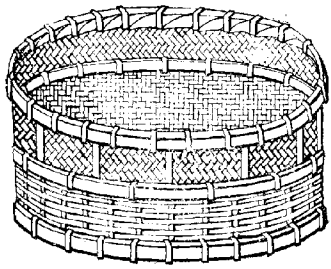

FIG. 2. Egg-basket.

the eggs before hatching, are useful, but are not absolutely necessary. They may be about a foot in diameter or of any convenient size.

(*c*) Baskets in which to place the full-fed worms which are about to spin their cocoons (Fig. 3). The ordinary

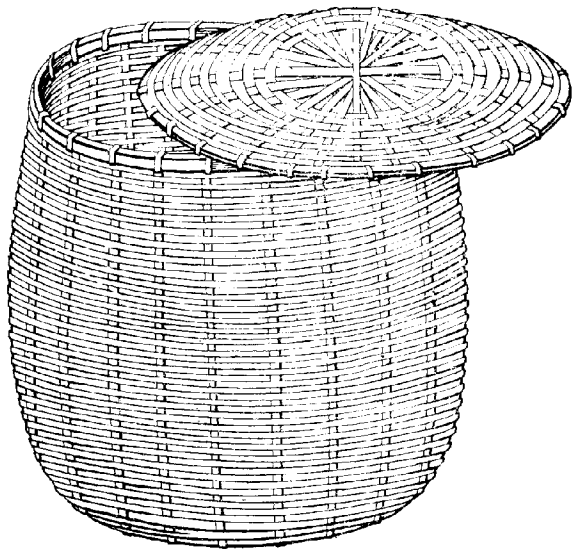

FIG. 3.—Spinning-basket.

bazaar baskets with lids will do very well; such are usually made of split bamboo or arhar stalks and are used for the despatch of fruit, etc. Baskets of some sort should be used for the worms to spin in, as they must have ventilation; if placed to spin in ordinary wooden boxes they will die of suffocation. If baskets cannot be obtained, the worms will spin up well amongst the folds of thin cloths hung over cords stretched across the rearing-room. The spinning-baskets should be about a foot deep and about a foot and-a-half in diameter and must be provided with a lid. On an average two such baskets will be required for every thousand worms put to spin.

(*d*) Bamboo or wooden *machans* (Fig. 4), on which to place

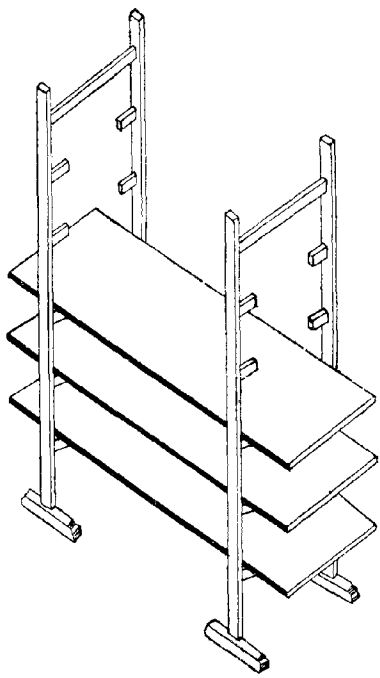

FIG. 4.—Machan for Rearing-trays.

the rearing-trays if more than a very few of these latter are being used. These are most conveniently

made of bamboos, the shelves being of cross-pieces of bamboo and not necessarily of planks as shown in the figure. The distance between the shelves on such *machans* should not be more than nine inches.

(*e*) Materials for the worms to spin their cocoons in. These may be wood shavings, dry leaves, dry straw or grass, crumpled paper, or any similar stuff which may afford the worms a shelter in which to hide; when obtainable, dry mango leaves are extremely suitable as they curl up to form a small space into which the cocoon just fits, thus obviating wastage of silk. As already mentioned above, clean cloths (such as old *dhoties* or *chaddars*) hung on cross-poles or lines can also be used for the worms to spin their cocoons within the folds. After removal of the cocoons these cloths may be washed and utilised again as occasion arises.

(*f*) Besides the foregoing, one or two empty kerosene tins, some copper sulphate and some washing soda may be procured beforehand so as to be ready when required. If washing soda cannot be obtained readily, sufficient castor ashes to meet requirements may be prepared by burning dry castor-leaves and stalks collected from the fields. A *Taku*, a *Charka* or a Pusa Continuous Spinning Machine would complete the list of things commonly required by a rearer on a small scale.

STAGES IN THE LIFE-HISTORY OF THE ERI-WORM.

Like all other moths, the Eri-worm passes through four distinct stages in its life-history. These are (1) the egg, which is quite inactive, (2) the caterpillar or worm which hatches out of the egg and feeds on castor-leaves until it is full-grown, when it spins a (3) cocoon of silk, from which (4) the moth emerges to lay its eggs, thus completing the cycle. It is only in the second (caterpillar) stage that the Eri-worm feeds; the egg and cocoon are both incapable of movement and the moth is sluggish and does not feed at all.

Eggs.

The eggs are white, small and globular, with a very tough smooth shell. In moist warm weather they hatch about eight days after being laid, in the hot dry weather after eleven to twelve days, and in cold weather they may take as long as three weeks. Moisture is a necessity

for successful hatching, and in dry hot weather they should be kept covered with a moist cloth. In cold weather they keep well and hatch uniformly if kept in a warm moist place; this is secured by covering the tray containing eggs with a wet piece of cloth and placing the tray thus covered in the sun, always taking care that the cloth does not get dry and that the eggs are not exposed to the direct rays of the sun. At other times of the year they do not require any special surroundings.

Eggs must never be kept in air-tight or ill-ventilated vessels or boxes. Dipping them in a solution of copper sulphate does them good; this solution is made up by powdering 1 tola (rupee weight) of copper sulphate and dissolving it in $1\frac{1}{4}$ seers ($2\frac{1}{2}$ lbs.) of cold water. The eggs are then tied in a piece of cloth and dipped in the solution until they are thoroughly wet; they should afterwards be dipped in pure water two or three times, the water then jerked out and the eggs spread in the shade to dry.

Eggs turn grey before hatching, so that this change of colour is an indication that the young worms will emerge in a day or two. Eggs laid on the same day usually change colour and emerge at the same time; if any eggs of a single batch fail to emerge at the same time as the others of the same batch, they should be rejected and not reared, as the fact of their lagging behind indicates a want of vitality. When the eggs turn grey, they should be spread out evenly and the smallest leaves of castor laid over them; as the worms hatch they crawl on to the leaves which may then be lifted up and placed in another tray with the worms on them.

Worms.

When the young worms hatch out from the egg, they are of a greenish-yellow colour with black spots. As the worm grows it becomes too large for its skin, and it ceases to eat for some time and remains almost motionless for one to three days according to temperature, and during this time it should not be fed or disturbed; presently the skin bursts at or just behind the head and the worm extricates itself from the old skin and commences feeding again. This process is known as moulting, and four moults are usually undergone by the worms. After the last moult the worms feed voraciously and grow very quickly until they are full-fed, when they stop feeding and begin to wander about, this being an indication that they want to spin their cocoons. At this time they are about four inches long and they may be green or whitish and with or without black spots; there seems to be no difference in the silk produced by the differently-coloured worms, but those worms whose bodies are covered

with the largest amount of a white waxy powder are generally the most healthy, and these should be kept for breeding if possible.

Cocoons.

When full-fed, the worm wanders away from the feeding-tray and looks for a suitable place to spin its cocoon inside of which it changes into a short cylindrical object technically known as the "pupa." The cocoon itself is of course only a silken protective covering and is not a part of the living animal, which is the pupa from which the moth emerges. Cocoons are usually whitish or reddish-brown; in their wild state a large proportion of cocoons are reddish-brown, but the white cocoons are more valuable as silk and, by breeding only from the moths which come out of the white cocoons, the brown ones may be eliminated.

Moths.

The moth is a large winged insect which does not feed at all and is very sluggish as a rule. Though provided with large wings, it rarely flies, although sometimes the males flutter about a little towards evening. The moths are only used for pairing to obtain fertile eggs for subsequent broods.

PRACTICAL HINTS ON REARING.

The treatment of eggs has already been dealt with in the last section (page 6), to which reference should be made.

The young worms, which have hatched out from the eggs and crawled on to the tender castor-leaves spread over these latter, should be transferred to trays and fed on young, tender castor-leaves which should be renewed twice a day or more frequently in dry weather if they become dried up. In hot dry weather the trays may be covered with a damp cloth to prevent the leaves from withering too rapidly. The leaves should not be chopped up, but each may be torn into two or three pieces. *Very great care must be taken that worms of the same age only are kept in the same tray.* All the worms that hatch on the same day should be kept together. Worms of different ages should never be kept together, as some will be trying to moult whilst others are actively feeding, and these latter will incommode the former. Besides, as the worms grow, their activity increases, so that the larger ones will cause a great deal of inconvenience to the younger ones. The young worms also are usually in the habit of feeding from the underside of the leaves supplied, whilst the large worms show a tendency to get upon the leaves and so may suffocate any smaller ones which may be kept with them. Of the worms that hatch on

the same day even, some grow more quickly than others, and it is better to sort them out if possible.

Worms must never be touched or handled if it can possibly be avoided. When cleaning the trays they can be transferred on the old leaves to trays containing fresh leaves and, when they have crawled on to the new leaves, the old ones can be picked out.

Always clean the trays regularly, at least once a day. Worms cannot be expected to thrive if they have to live and feed on a rotting mass of old leaves and excrement.

Worms which have stopped feeding in order to undergo a moult must not be disturbed until they have cast their skins, and fresh leaf should not be given until they have done so.

The less crowded and the cleaner the worms are kept, the better they will thrive. Young worms require tender leaf; older and larger leaves may be given as they grow older.

Never give worms leaf which is dusty or wet. If the leaves are covered with dust this may be washed off in water. To remove excess of moisture from leaves they should be put in a cloth the four corners of which are then gathered up and the whole bundle whirled around so as to drive out the drops of water by centrifugal action; by this means the water is expelled without bruising the leaf. Leaf must always be fresh. Never feed stale leaves to the worms if it can possibly be avoided; leaves that have been brought from a distance or which have been lying in heaps for some time are apt to cause disease in the worms.

Try to get fresh eggs every now and then and do not inbreed your broods for more than one season at the most. Always get eggs from outside sources; never get live cocoons for rearing as these may introduce a parasitic fly which sometimes does great damage to the worms.

If the air in the rearing-house becomes too dry, sprinkle water over the floor in order to keep it moist.

If any worms drop from the trays they should be picked up and replaced.

If any worms are found dead in the trays, they should be removed promptly and destroyed—by burning if possible.

Do not allow worms to spin in the rearing-trays. If any cocoons are found therein, they should be removed.

The dead and uneaten leaves and excrement removed when cleaning the trays should be buried in a deep pit and allowed to

rot in the ground for at least a year, after which it may be used as manure for the castor-plants or for other purposes.

In ordinary weather the worms should be fed daily as follows:—

On hatching, twice.

After first and second moults, thrice (once at nightfall).

After third moult, four times (once at night).

After fourth moult, five or six times (once or twice at night).

In hot dry weather they should be fed oftener if they are restless or the leaves wither up. Worms in the last stage, before spinning up, are very voracious and should be given as much leaf as they will eat. Worms which are not well fed cannot be expected to yield good cocoons.

When full-grown and about to spin cocoons, the worms, which are white, turn yellow; the green ones remain green. It is easy to determine whether any worm is ready for spinning: hold the worm with your finger near your ear and pass the fingers lightly over the fleshy spines on its back: if the worm is ready to spin, a hollow sound will be clearly perceptible: otherwise the sound will be dull and solid. As a matter of practice, however, the sound-test has rarely to be employed, as worms which are ready to spin stop feeding, pass a large quantity of semi-solid and liquid excrement and then commence to wander about in search of a suitable place in which to spin up: this they usually do in the morning between 9 A.M and noon, and they should then be picked out and placed in the spinning-baskets which have already been filled with dry leaves, etc. (see page 5). The worms tend to crawl upwards in the basket, so that care must be taken not to leave an empty space below the lid; the basket should be completely filled with the spinning-medium: otherwise many worms will collect in this empty space and waste a large amount of silk in filling it up. If enough worms are full-fed at one time, it is best to fill the spinning-basket with alternate layers of material (dry leaves, etc.) and full-fed worms. Not more than 500 worms should be placed in one basket of the dimensions given. When filled the basket should be closed with the lid and a weight placed on this, or the whole basket may be turned upside down.

The worms must have ventilation when spinning their cocoons, so that baskets should be provided for this purpose; wooden boxes are not suitable.

After five days in summer and eight days in winter the cocoons may be picked out from the spinning-medium and the baskets used for a fresh lot of worms.

In their wild state many of the cocoons are of a brownish-red colour; if any such cocoons are produced by worms in confinement, they should not be kept for breeding purposes. Only those moths which emerge from white cocoons should be allowed to breed and lay eggs.

The cocoons, after being cleaned from the spinning-medium, should be spread out in rows on trays. After about ten days in warm weather and up to about forty days in the winter, the moths come out. They should be left alone for some hours and then placed in an empty basket covered with a lid—a spinning-basket does very well. They will sit on the sides and pair. Next day pick out all the unpaired moths and leave the pairing couples alone until the day after, when the females (which have large bodies) may be picked out and put into another basket whilst the males (which have small bodies) may be thrown away or fed to fowls. The females will lay eggs on the sides of the basket in which they are placed; the best eggs are laid the first night, usually about 80 eggs being laid then by each female, so if these are sufficient for rearing the next brood keep these only and not those laid later on. In any case, eggs laid after the third night after separation from the male *should* not be kept, as such are very inferior. The eggs may be scraped off with a blunt knife or stick. In cold weather, the moths will not pair as a rule unless kept in a warm room.

After rearing each brood and before using the trays and baskets again, be careful to wash them in a solution of 1 tola (rupee weight) of finely-powdered copper sulphate dissolved in $\frac{1}{2}$ seer (1 lb.) of cold water. After being washed the trays and baskets should be exposed to the sun.

DISEASES, ENEMIES AND CLIMATIC INFLUENCES.

Eri-worms are subject to many diseases, but these will not usually do much damage if attention is paid to the following points, *viz.*, avoidance of continuous inbreeding by obtaining frequent supplies of fresh eggs from other localities, avoidance of overcrowding of the worms and accumulation of dirt in the trays, giving the worms only fresh leaves (and not stale, dusty or wet leaf), keeping the trays clean and disinfecting them with copper sulphate solution after each rearing, and making proper arrangements beforehand for an adequate supply of leaf before commencing to rear. Worms which are kept under proper sanitary conditions and fed with good leaf rarely develop disease on any scale, whilst rearers who feed their worms badly or carelessly often have their broods wiped out by disease.

In some districts the parasitic fly is an important enemy of silk-worms, and for this reason eggs should always be obtained from outside localities in preference to cocoons which may introduce the fly. The fly itself is rather larger than a common house-fly and has a more hairy body: it lays its eggs on the worms and its maggots live inside the worm and kill it, coming out to pupate when full-fed. Any white fat maggots seen in the trays with the worms or cocoons should be promptly destroyed.

Rats are determined enemies of Eri-worms, cocoons and moths, and often do great damage. They must be trapped or poisoned. Flour mixed with a little Plaster of Paris and laid down amongst the trays is a simple poison for rats if they cannot be trapped.

Birds, bats, wasps, lizards, toads, etc., often also attack the worms, but these can generally be kept out of the rearing-house without much difficulty.

Climate is an important factor in rearing. The ideal conditions seem to lie in temperatures between 60° and 90° (degrees Fahrenheit), possible conditions between 50° and 100°. When the temperature exceeds 100° it becomes very difficult to rear the worms, and this can only be done with some measure of success if the atmosphere in the rearing-house is kept damp by sprinkling water on the floor, etc. When the temperature drops below 50°, the eggs do not hatch, the worms feed only very slowly and the moths do not emerge from the cocoons, or, if they do emerge, they usually fail to couple or lay eggs. At low temperatures also the full-fed worms fail to spin their cocoons. Under such conditions the temperature should be raised artificially to 70° if possible.

TREATMENT OF COCOONS.

Cleaning.

Cocoons in their natural state contain the cast skin of the worm, the empty pupa-shell from which the moth has emerged and (very often) dead worms, pupæ, or moths which have failed to emerge at all. If these cocoons are carded, these remains get broken up, mixed with the silk and have to be removed by special methods. If the cocoons are used for spinning, the spinner must use care to avoid spinning in fragments, must waste the inner layer of the cocoon, and, in boiling the cocoons, much dirt comes out in the water and stains the cocoons. It is therefore in every way desirable to clean the cocoons, and this may be done with the aid of the Coryton Reversing Machine, a simple machine worked by hand and by which the

cocoons are turned inside out and all waste material eliminated.

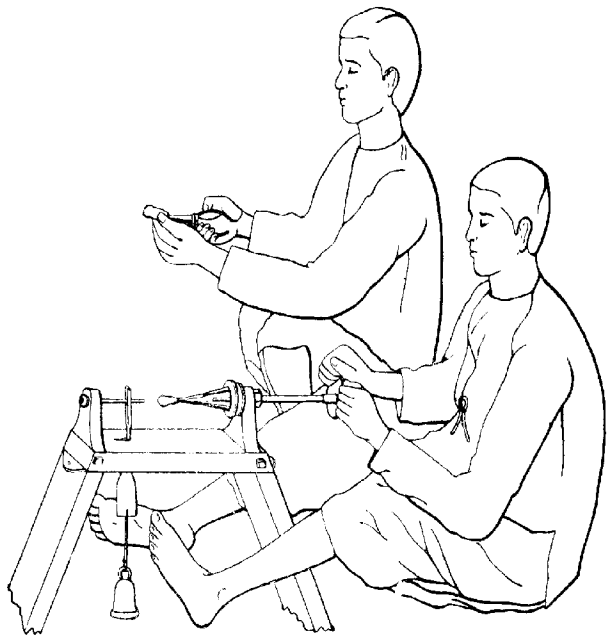

FIG. 5.—Coryton Reversing Machine.

Boiling off.

The figure shows the machine in action. After cleaning, the cocoons should be soaked in clean water for 18 hours and then be washed well in fresh water, squeezing them with the hands until all the dirt is removed. They should then be placed in boiling water to which has previously been added washing soda of one-quarter the weight of the cocoons, that is to say, two chittacks (4 oz.) of washing soda to every $\frac{1}{2}$ seer (1 lb.) of cocoons. The cocoons should be tied up in a cloth and dropped into the boiling solution, the bundle being kept submerged by placing a brick or stone on top of it. Boil for three-quarters of an hour. Then lift out the bundle of cocoons and keep the boiled-off liquid for dyeing, if any dyeing is to be done. Wash the bundle, without untying it, in clean water until no more dirty water comes out of the cocoons. These are now ready for dyeing or spinning. If spinning is to be done with the *Taku* or Pusa Continuous Machine, use wet cocoons. If the *Charka* is used, dry the cocoons thoroughly and then spin from the dry cocoons. Dry cocoons can be carded out and spun like wool, but it is better

to spin direct from cocoons. A seer (2 lbs.) of cocoons will yield 10 to 12 chittacks (20 to 24 oz.) of thread.

Carding.

Boiled dry cocoons are very readily carded by hand for hand-spinning, and this effects a separation of the dirt contained in the cocoons from the fibre. The simplest method is simply to take each cocoon in the fingers and with each hand to loosen the cocoon gently until it all comes away as a soft fluffy mass, leaving the very thin inner shell holding the empty pupa-case and skin of the worm. (In the case of reversed cocoons, these have of course been got rid of already.) Separate carding is not required when spinning has to be done either on a *Charka* or the Pusa Continuous Machine.

Spinning.

There are three methods of hand-spinning: (i) the *Taku*, (ii) the *Charka*, (iii) the Pusa Continuous Machine.

Taku.

The *Taku* is a simple spindle with a weighted end. The spindle is attached to the drawn-out end of the dry or wet cocoon and spun around with a twist of the hand, the thread being drawn out evenly with the

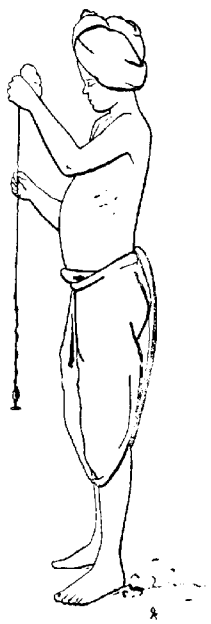

FIG. 6.—Spinning with the Taku.

fingers until the spindle falls sufficiently, when the thread formed is wound off, and the spindle again spun to twist a fresh length. It is a slow process, but the use of the *Taku* is known to every village woman who has to spin cotton. It is the least economical method of spinning, although it produces good thread.

Charka.

The *Charka* is familiar wherever cotton is spun. Dry or carded cocoons are spun very well upon this machine, which makes very good thread. The only disadvantage is that the process is not continuous, as the

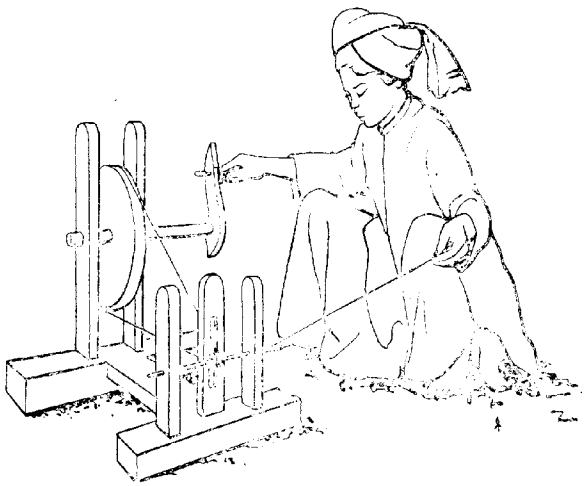

FIG. 7. Spinning Thread on Charka.

wheel has to be stopped to wind the finished length of thread on to the spindle, and only one hand is available to hold the cocoon, the other being required to turn the wheel.

Pusa Continuous Machine.

The Pusa Continuous Machine is an improvement upon the *Charka* as it avoids any stoppage of the operation for winding off the thread. It consists of a pulley, turned by a treadle and belted to a flying needle which is a wire with a loop at the end and other loops on the arms. It revolves around the spindle, which revolves more slowly, and the thread is fed in at the base of the needle or through the loop at the end: the spinner has both hands free to draw out the cocoon into a proper length and feed it continuously to the thread.

The principle of the machine is this:—A thread passes to a point revolving around a revolving spindle and from it to the spindle: if the two revolve at the same rate the thread is only

twisted or only wound on the spindle according as they revolve in the same or opposite directions, but if they revolve at different rates the thread is dragged from the revolving point and wound off upon the spindle; in so doing, the revolutions of the point give a twist to the thread and, if the fine end of the cocoon is fed in, it becomes thread as it is drawn off and twisted. If the two motions are adjusted, one can get in a given length a definite amount of twist; thus, if one inch of thread is drawn in while the flying point makes six revolutions, the thread will have six twists in one inch. To secure that there shall be a difference in the rates of motion of the spindle and the needle can be done in two ways; they may be driven by belts off pulleys of unequal size, or the spindle may be free to revolve and slightly "braked"; if the spindle is free to revolve the thread drags it around and is not wound off, but if the spindle is braked by friction it turns more slowly than the needle and so pulls off the thread. These machines may be obtained with either single or double spindles, the latter of course spinning two threads at once.

Preparation of thread for weaving.

The thread as prepared by the spinner undergoes no special preparation before it is used for the warp or put in the shuttle, except the processes usually adopted by the local weavers with cotton thread, and these processes are equally applicable to Eri thread. The warp threads

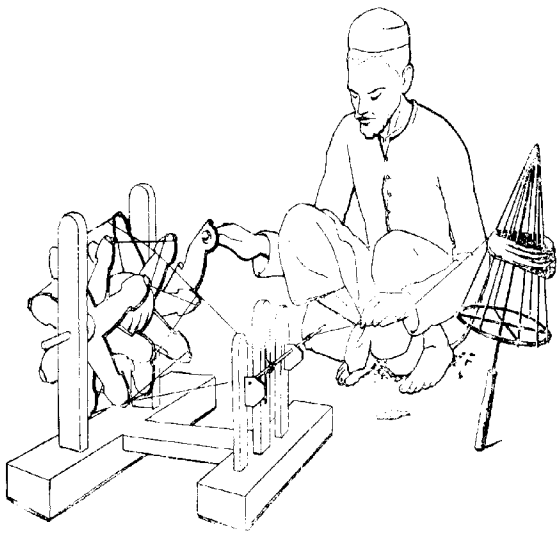

FIG. 8.—Filling Bobbins for the Loom-Shuttle.

are run off on to big spools, warped, the warp arranged, stretched, sized and brushed. The weft threads are run off on to small pirns for the shuttles and kept wet until wanted.

In case extra thick thread is required for the border, two or more threads are twisted together either in the usual way off bobbins on a *Charka* or in whatever way is used locally.

WEAVING.

The threads produced from the *Charka, Taku* or the Pusa Machine are woven in the usual way on the ordinary handlooms generally used in all villages. They are not adapted to power-looms in which they will break. A loom that weaves cotton will also weave hand-spun Eri silk, but which loom will suit any particular locality depends purely on local circumstances.

In the ordinary hand-weaving with hand-spun thread, there is no necessity to have a fly-shuttle loom or an improved pattern of any kind. The best loom is the ordinary handloom in which the shuttle is thrown by hand. For weaving greater breadths than 36 inches, a flying-shuttle Barabanki loom may be used, the picking being done by pulling a cord. For weaving fine even cloth from hand-spun thread a reed of 20 to 22 dents should be used: for coarser thread a reed of 14 to 16 dents may be used.

The warp threads must be sized just as cotton threads are, or they cannot be woven at all: sizing is done in the same way as in the case of cotton.

To size a piece of Eri cloth 3 yards long and 52 inches broad the following ingredients are required: —

(1) Rice, 6 chittacks; water, 1 seer 6 chittacks.	Boil until thoroughly cooked. Then strain the thick gruel through a piece of cloth and keep aside.
(2) *Mœna*, 3 chittacks; water, 6 chittacks.	The clean grain is ground fine into a thin pulp with water on a stone slab and strained through a cloth. The residue is again ground fine and strained until nothing is left.
(3) Linseed, 1½ chittacks; water, 4 chittacks.	The clean seed is ground fine as above and strained through cloth. The thick mucilaginous liquid is mixed with (2), and the whole then mixed with the strained rice gruel which is again cooked over a slow fire until all the ingredients are thoroughly worked up. If, however, the liquid becomes thick, more warm water is added at intervals. The mixture is then taken off the fire, allowed to cool, and applied to the Eri warps stretched on two upright poles with a brush (*Koonch*) which is repeatedly worked up and down until the warp threads are uniformly coated with a thin layer of the size. When sufficiently dry the warp threads are carefully rolled and passed through the reeds and healds and woven in the same way as cotton.

ERI-SILK FABRICS.

As a rule, Eri silk is woven into a moderately coarse cloth, either for suits or for use as whole pieces uncut as wrappers, *saris*, *dhoties*, etc. With ordinary spinning and weaving, heavier cloth is produced suitable for wearing, for table-cloths and curtains, and for those fabrics in which strength and durability are required.

Most silks deteriorate with use; Eri silk improves since the soft fibre loosens a little, fills in the fabric between the threads, and thus gains in lustre and softness. It must also be remembered that Eri cloth, as usually made from hand-spun thread, does not shrink, but in time stretches a little. This must be allowed for, as it is one of the peculiarities of this cloth.

Very fine cloth can be made from mill-spun Eri thread. This is usually prepared of count 160/2, and is obtainable from the Silk Mills at Bombay.

Ordinary undyed cloth is "finished" in a variety of ways, according to the appearance required. Ordinarily, the cloth is washed in hot water with soap and then dried and ironed; this leaves its colour unchanged.

Attention may be drawn to the very great value of boiling the cloth, in all processes, as this improves it very considerably. Eri-silk fabrics improve very much by use and washing; at first they appear rough, coarse and dull-looking, but a great deal of this appearance is removed by boiling them in water with or without soap or soda. A simple way of getting a good cream colour is to boil the cloth for one or two hours with $\frac{1}{8}$ of its weight of bar-soap and then to expose it to the sun for a few days.

DYEING.

The dyeing of Eri silk is the same as that of other silks and, since the fibre is white, bleaching is not usually required except for special purposes. In fact, Eri silk, being itself pure white, takes dyes better than other silks if properly handled and kept clean.

For dyeing Eri silk, attention may be drawn to lac-dye obtained by washing crude scraped lac in water and precipitating the dye with lime. The cloth is mordanted with alum, and in some cases acids are added to the dye-bath. The colour produced is a deep or bright red. Lac-dye is an especially good dye for silk and is deserving of much more extensive use. Of other "natural" dyes, good

fast colours are also obtained with Indigo, Sapan (or Bakam), Palas (or Dhak), Madder (*Manjista*) and Jackwood (*Kanthal*).

Fuller particulars regarding dyeing of Eri cloth with "natural," Alizarin and Aniline dyes will be found in this Department's Memoir on Eri Silk (Entomological Series, Vol. IV, No. 1).

THE CULTIVATION OF CASTOR.

There are various local varieties of the castor plant, but apparently nearly all of them are suitable for the feeding of Eri-worms. The area on which the plants are grown should be reasonably near the rearing-house so as to facilitate plucking and transport of the leaves.

When commencing to plant, if farmyard manure is available, it should be applied to the land at the rate of 20 cartloads per acre during May or in June before the rains begin, and it should be thoroughly incorporated with the soil. If manure is not available, land which has just previously borne a leguminous crop should be selected for sowing castor if possible. The land should then be ploughed thrice and brought into a fine state of tilth. With the first fall of rain, good plump seeds should be sown in lines 4 feet apart, at the rate of 10 seers per acre, with a *sarta* (bamboo funnel for dropping seeds) attached to a plough. When the seeds have germinated, any gaps should be filled in by hand, and the intervening spaces between the rows of castor should be worked over with a bullock-hoe to keep down weeds and conserve moisture. In districts where the bullock-hoe is not used, the ground may be hand-weeded so as to remove weeds and prevent undue evaporation of the soil by caking. When the plants are a foot above the ground, they should be thinned out by removing the weaklings and such as appear to be pale and sickly in growth. Two or three such thinnings will be required before the plants are 4 feet apart each way. When they are 3 feet high their top-shoots should be nipped off by hand so as to induce more lateral growth. The tips of the side-shoots also should be cut back so as to induce them to throw out more leaves. In some two and-a-half months after sowing the plants will be ready for plucking, and in doing this it is as well to bear in mind that the plants must not be stripped outright of their foliage, but that a systematic and judicious system of plucking the leaves ought to be adopted so as not to injure the plants unduly whilst taking a maximum quantity of leaves from them. This is secured

by plucking the lower leaves first and then gradually moving upwards until the previous strippings are replaced by fresh growth. Plants thus plucked yield 80 maunds of leaf per acre, besides 10 maunds of cleaned seeds.

When rearing worms forethought must be taken to see that leaf will be available for them.

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
8, HASTINGS STREET